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Reducing Mercury Use by the Amalgamation of Concentrates vs. Whole Ore

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Largest gold rush the world has ever seen!

- 10 to 15 million artisanal miners producing 600-800 tonnes Au/a in more than 70 countries
- About 50-100 million people directly and indirectly involved in artisanal gold mining



Guinea, 2006

Environmental Problems Caused by Artisanal Gold Mining

- **Water siltation**
- **Landscape degradation**
- **Destruction of habitats**
- **Loss of organic soil**
- **Deforestation**
- **Mercury pollution**

Why Artisanal Miners Use Hg?

- Mercury amalgamation is an ancient technique but still useful for artisanal gold miners
- Main reasons by which Hg is widely used by ASM:
 1. Simple
 2. Cheap (1kg Hg = 1g Au)
 3. Accessible
 4. Often unawareness about the risks



Senegal, 2006

Two Main Sources of Hg Pollution from ASM



Burning Amalgam

Main HEALTH Problem



Whole Ore Amalgamation

**Main ENVIRONMENTAL
Problem**

Loss of Hg depending on the procedure

**Amalgamation of
the whole ore**
and/or

**Cyanidation of Hg-
contaminated tailings**



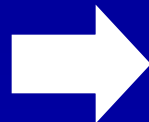
Huge Hg losses



Hg⁰ → CH₃Hg in fish

Hg⁰ vapor → lungs

**Burning
Amalgams in Pans**



**Health problem for
miners, and community**

China



Amalgamation of the Whole Ore = Hg is lost to the Environment



Indonesia, Talawaan, 2001

- Adding Hg into the Grinding Circuit
- About 30% of Hg added is lost
- About 20 tonnes/a of Hg are lost in Talawaan, Indonesia

Amalgamation of the Whole Ore = Hg is lost to the Environment



Zimbabwe, 2005

**Use of Copper
Amalgamation
Plates
Generates
High Hg-
Tailings**

Hg-contaminated tailings are submitted to cyanidation in Colombia



Colombia, 2007

- Hg in ball mills
- 50 to 100 tonnes/a lost in the Antioquia Province.
- Hg-contaminated tailings go to cyanidation

Hg-contaminated tailings are submitted to cyanidation in Zimbabwe



- Tailings from the Hg-copper plates are submitted to cyanidation
- Hg becomes soluble and bioavailable (easier to be methylated)

Zimbabwe, Kadoma, 2005

Hg-contaminated tailings are submitted to cyanidation in Indonesia



North Sulawesi, Indonesia, 2005

Hg-contaminated tailings are submitted to cyanidation in Indonesia



Tailings with Hg cyanide are poorly stored and reach the streams

Hg-contaminated tailings are submitted to cyanidation in Ecuador

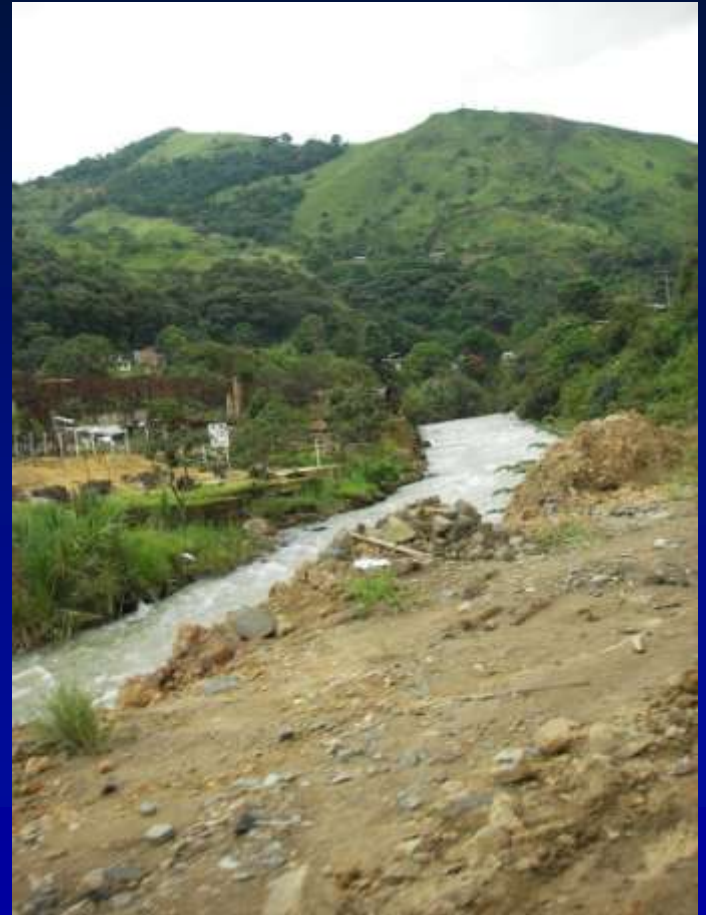


92 cyanidation tanks in the town of Portovelo leaching Hg-contaminated tailings

Ecuador, 2007

Hg-contaminated tailings are submitted to cyanidation in Ecuador

Tailings with Hg cyanide are dumped into the Amarillo River



Hg-contaminated tailings are submitted to cyanidation in Brazil

- Abandoned cyanidation heap in São Chico, Brazil near a water stream
- Hg-cyanide in tailings reach the rivers



Brazil, São Chico, 2003

Hg-contaminated tailings are submitted to cyanidation in São Chico, Brazil

- **Carnivorous fish, Ave = 4.16 ppm Hg**
- **Non-carnivorous, Ave = 1.33 ppm Hg**
- **60% of fish >0.5 ppm Hg**
- **One fish sample = 22 ppm Hg**

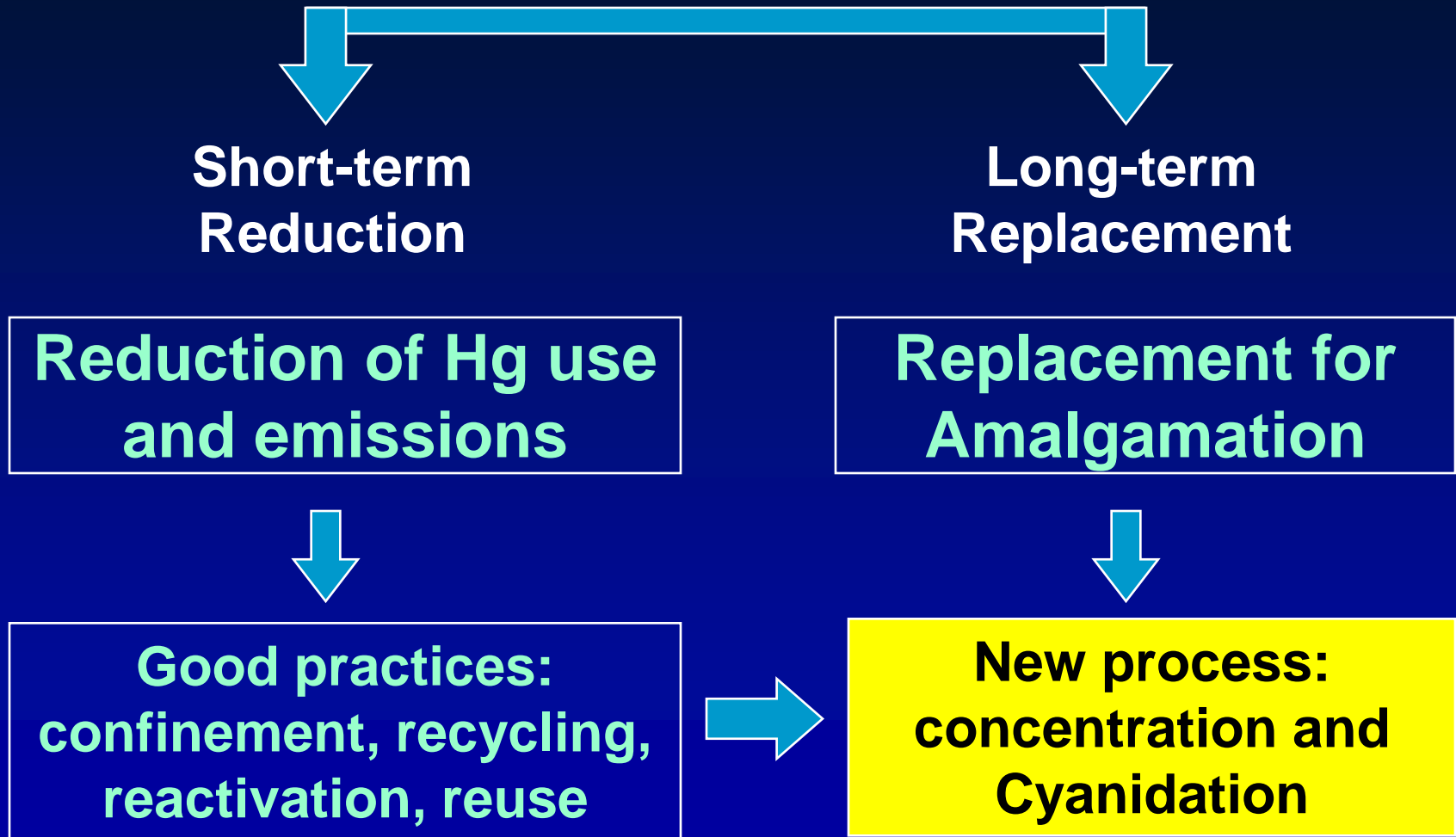
WHO max guideline for edible fish = 0.5 ppm Hg

Source: Rodrigues et al., 2004

Many alternatives to Whole Ore Amalgamation exist, including:

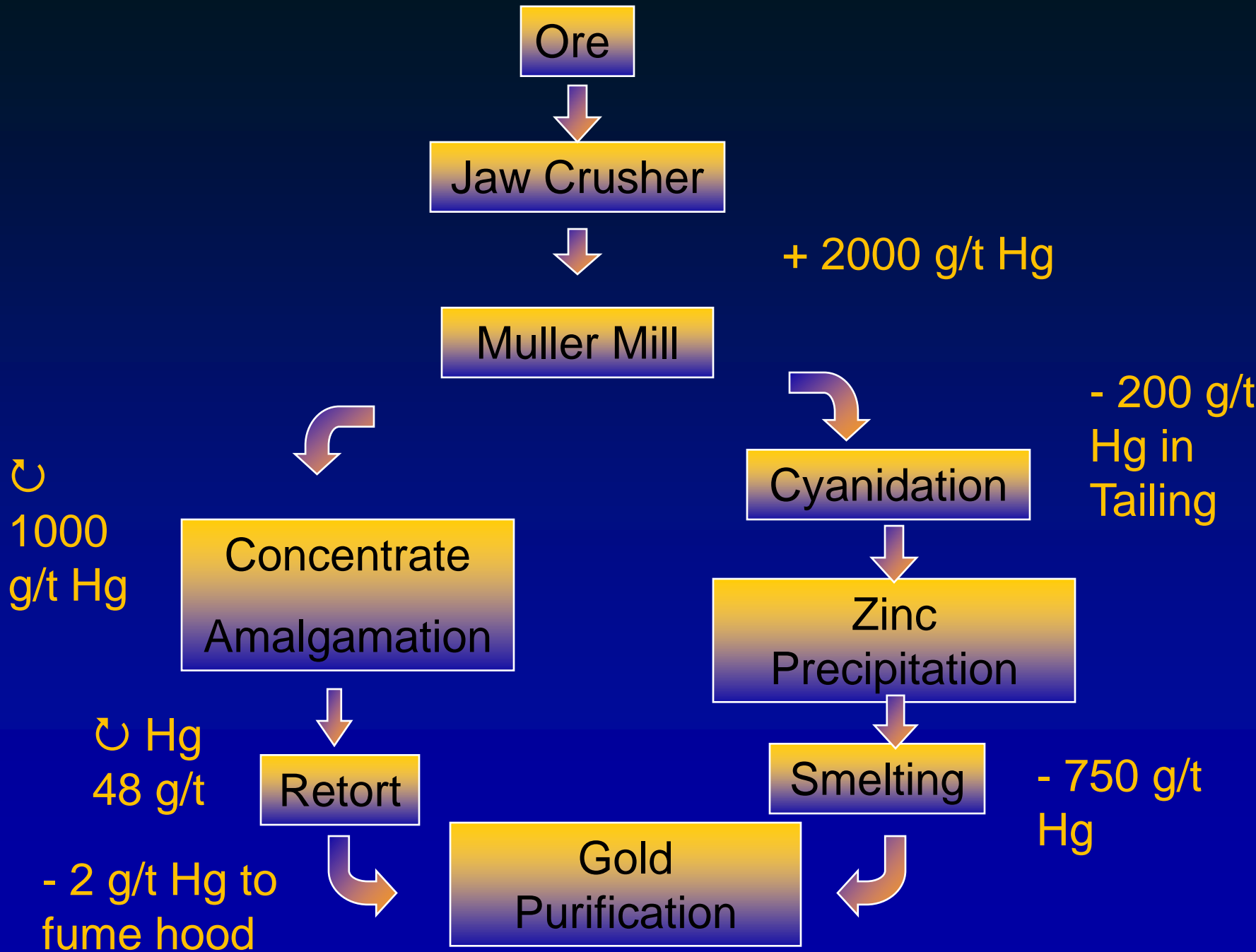
- Gravity (panning, sluices, spirals, centrifuges);
- Magnetic separation;
- Flotation;
- Cyanidation (and other hydrometallurgical processes); &
- Various combinations of these processes.

Solutions Being Introduced



Technology Demonstration





50 g/t Au
Recoverable

Ore

Jaw Crusher

Muller Mill

Alternative
Technology

Cyanidation

+ 100 g/t Hg

Concentrate
Amalgamation

↻ 60 g/t
Hg

Zinc
Precipitation

↻ Hg
48 g/t

Retort

Smelting

- 2 g/t Hg to
fume hood

Gold
Purification

Demonstrating Availability of Gold Concentrators and How to Improve Efficiency



Amalgam roasting



Alternatives to open burning of amalgam

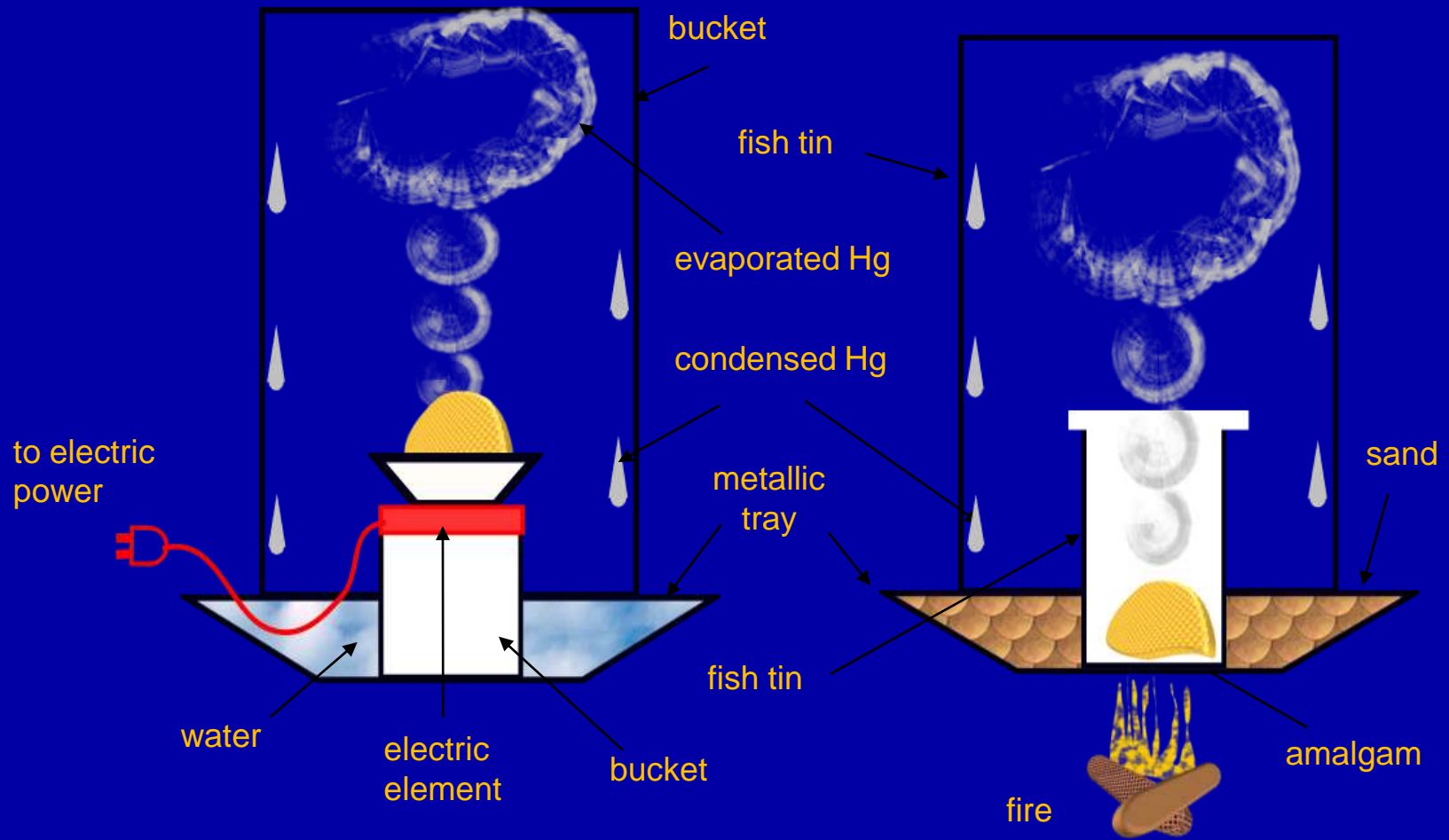
- Retorts;
- Panning and magnetic separation;
- Tabling;
- Direct smelting; and,
- Leaching.

Gold Mountain Retort

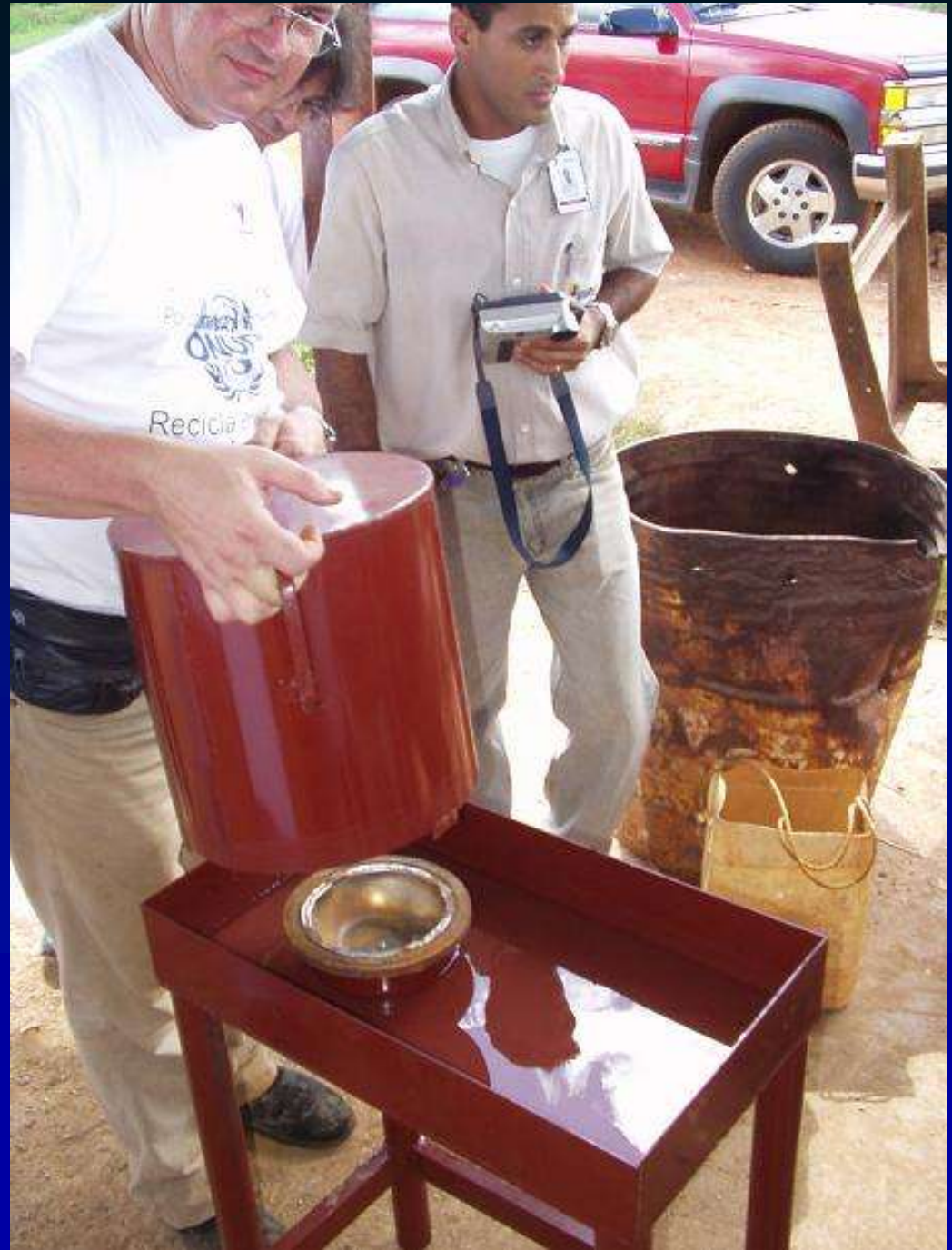


Bucket Retort (China)

Fish-tin Retort (Papua New Guinea)



Modified “Chinese” Retort in Venezuela



Venezuela, 2003

Share Good Practices



Recommendations

- Stop Whole Ore Amalgamation
 - Especially grinding with Hg
 - Especially treating the tailing with cyanide
- Encourage alternatives to open burning of amalgam



Thank You !



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